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STUDY PROJECT

A TERRAIN STUDY OF THE GETTYSBURG BATTLEFIELD

BY

MR. THEODORE W. HOWARD

7 APRIL 1986

US ARMY WAR COLLEGE, CARLISLE BARRACKS, PA 17013

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Many historians have studied and restudied the Battle of Gettysburg during the Civil War. As a result, numerous conclusions have been reached based upon Confederate and Union Force structure, tactics utilized, weapons capabilities, and individual personalities as to the outcome of the battle. Little investigation has centered on terrain and its possible effect on military planning and operations during the battle. This study is an attempt to set the stage with respect to depicting the terrain as it existed during

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USAWC MILITARY STUDIES PROGRAM PAPER

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AN INDIVIDUAL STUDY PROJECT

BY

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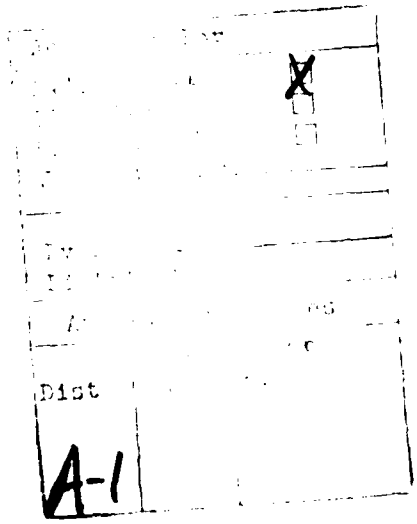

ABSTRACT

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Many historians have studied and restudied the Battle of Gettysburg during the Civil War. As a result, numerous conclusions have been reached based upon Confederate and Union force structure, tactics utilized, weapons capabilities, and individual personalities as to the outcome of the battle. Little investigation has centered on terrain and its possible effect on military planning and operations during the battle. This study is an attempt to set the stage with respect to depicting the terrain as it existed during the 1860's. Data were gathered using map and aerial photographic analysis, literature search, personal interviews, and quantitative models. Terrain data bases consisting of surface configuration (slope), drainage, surface materials (soils), vegetation, and lines of communication were prepared in order to derive the potential effect of terrain conditions on military operations during the battle. In addition, mapping capabilities which existed during the period were also examined for its utility in planning and conducting the battle. The results of the study are not conclusive, but surely the effective utilization of terrain had a clear, recognizable impact on the outcome.

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CHAPTER I

INTRODUCTION

Throughout history terrain has played a very important part in the outcome of the battles fought. One might argue that terrain has been considered to be critical to any military operation. Whether the terrain is used effectively to plan and execute military operations will surely have a bearing on the commander's success. Certainly there are other aspects of war planning and execution which are also critical, such as military capabilities, political climate, economic conditions, etc. But the effective utilization of terrain and weather ranks very high on the "war making" scale. Historians can bear witness to the fact that terrain has played a critical role in the outcome of numerous battles fought during the Revolutionary War, Civil War, World War II, Korean Conflict, and Vietnam. It is the purpose of this paper to examine the conditions of terrain at the Battle of Gettysburg. In addition, an examination of how terrain conditions were depicted on the maps of the period will provide some appreciation of what the commander had to work with in planning the battle.

If we were to consider the importance of terrain intelligence or terrain analysis in modern times, we would find that terrain has become and is becoming more and more important to our capability to fight. Most weapon systems and weapons support systems require some form of terrain data to function, i.e., Pershing II, Firefinder, GLCM, cruise missile, etc. Consequently, although armies during the Civil War did not have these sophisticated systems, the ability to use rifles and artillery effectively depended on the same terrain characteristics as today's systems.

FM 30-10 defines terrain intelligence as, that terrain information which is independently meaningful and can be utilized directly in support of

operations, or has potential value for future operations. AR 310-35 defines terrain intelligence as processed information on the military significance of natural and manmade characteristics of an area. Resultantly, terrain analysis is the process of analyses of a geographical area to determine the effect of the natural and manmade features on military operations. Therefore, as stated previously, this paper is an attempt to determine the significant terrain conditions which may have influenced the outcome of the Battle of Gettysburg.

TERRAIN DATA IN THE 1860's

Research indicates that GEN Robert E. Lee's forces had available to them for planning and execution of the battle a map of Adams County (Figure 1). Mapping during the period was primarily an art rather than a science. Consequently, maps were generally a crude pictorial representation of an area and generally reflected lines of communications patterns, such as roads, railroads, urban centers, etc. At best, maps had very little positional accuracy and depicted little or no topographic information, such as elevation and slope protrayed by contour lines. Hachures and form lines depicted the general topographic setting. In general, maps were rare items for many areas of the country and, in cases where they existed, many times they were very small scale. This is the case with respect to Gettysburg. The Adams County map displayed the routes to Gettysburg reasonably accurate and were an asset to planning route movement for the Confederate forces, but was of little value in planning and executing the battle. An appreciation of the terrain could not be obtained through topographic evaluation. Obstacles to movement were not depicted, key terrain could not be selected, fields-of-fire could not be


GETTYSBURG

predetermined, and avenues of approach were limited to road and railroad nets. Consequently, maps of the era were of limited value to the operational level of war and were of minimal value to the tactical level.

CHAPTER II

STUDY APPROACH

Several types and dates of aerial photographic coverage were evaluated to develop the detailed topographic conditions of the area. The use of aerial photography in preparing the terrain data involves the systematic study of visual elements relating to the origin, geomorphic history, and composition of distinct landscape units that appear in aerial photographs. For example, through the analysis of pattern elements visually apparent on an aerial photograph, the geomorphic composition or parent material of a site is interpreted or inferred.

The visual pattern elements examined in photo analysis include topographic form (slopes or landform), drainage patterns, gully characteristics, erosional features, vegetation characteristics, soil type, color or photographic tone, and any other special features that may be present. Each element was examined in three ways: separately, in relation to one another, and in relation to the entire pattern. Interpretation of the visual pattern elements is made by formulating a hypothesis which indicates the specific element of a particular site. The hypothesis was verified--and modified, if necessary --by examining certain elements in more detail, consulting other sources of information, and making field checks. The entire process relies upon the fact that similar features under similar conditions have the same combinations of the same pattern elements. That is, residual shale formations in North Dakota are similar to those found in California.

GEOGRAPHIC SETTING

Geographically the area around Gettysburg can be described as rather hilly. Along the northwestern border of Adams County is the elevated range called the South Mountain, and many hills and ridges of trap rock traverse other parts of the area. Adams County has no large streams; only Marsh creek, Rock Creek, and other branches of the Monocacy which flow southward into Maryland. The Bermudian and Conewaga, in the eastern part of the county, are the principal creeks. Gettysburg, situated in the southern part of the county, lies between Marsh and Rock Creeks. It is 114 miles from Philadelphia, 52 from Baltimore, 24 from Chambersburg, and 32 from Hagerstown.

Geological features of the county are diversified. A belt of limestone passes through the southeastern corner, from near Hanover in York County, by Littlestown, near the Maryland line, where it runs into a point, being overlapped by the middle secondary red shale and sandstone. This latter formation prevails over the greatest portion of the county, being broken, however, in many places by ridges and dikes of trap rock, which form rough and rocky hills.

CHAPTER III

DATA BASE DEVELOPMENT

Specifically, aerial photographic coverage ranging in scale from 1:15,840 (large scale mapping photography) to 1:60,000 (high altitude photography) and ranging in dates from 1937 to 1978, were acquired from the U.S. Geological Survey and the Department of Agriculture. This coverage served as the basis for producing the required information. In addition, soil and forest surveys, along with numerous maps and ground photography (both historic and current), were also evaluated to verify the data interpreted.

Several data base factor overlays depicting terrain conditions over the area were produced, to include slope (surface configuration), vegetation, surface materials (soils), lines of communication, and drainage. These data are required to determine the resultant impact on the battle, if any. Each factor overlay is discussed independently and describes the characteristics of the terrain feature as they presumably existed during the battle in 1863. In that aerial photographic coverage did not exist during that period, some of the data depicted are inferred based upon tree growth rates and manmade changes.

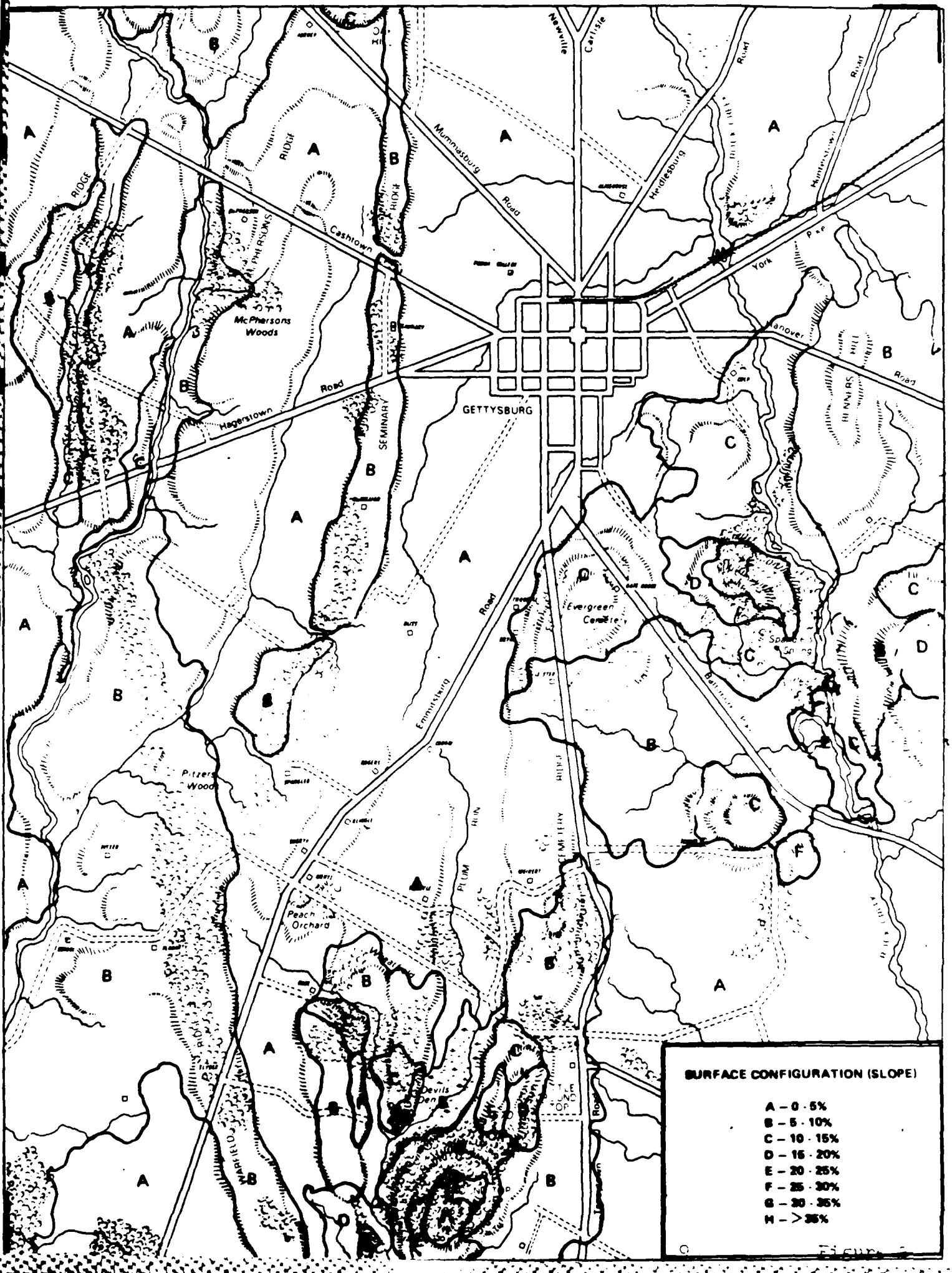
FACTOR OVERLAYS

SURFACE CONFIGURATION (SLOPE)

The Gettysburg battlefield is located between Marsh Creek and Rock Creek on gently to moderately rolling terrain in southern Adams County, PA. Slope generally ranges between 5 and 10 percent for most of the area. Several prominent hills are located south and southeast of the city. Slope ranges in excess of 30 percent along the steepest sides of Round Top, Little Round Top, and Culps Hill and between 10 to 30 percent on the less steep sites. Elevations reach approximately 800 ft. Several lesser ridges extend north-south just west and south of Gettysburg. Differences in elevation between valley floor and ridge top generally range between 20 and 30 feet and portions of Cemetery Ridge are less than 20 feet above the surrounding terrain (Figure 2 exemplifies general slope characteristics.) Some slopes become steeper than generally shown along the major drains.

SURFACE MATERIALS (SOILS)

Soils are classified according to one soil association. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil. The soils west of Gettysburg belong to the Klinesville-Penn-Abbottstown-Croton association. In this association the low hills and broad gentle slopes of the Gettysburg Plain are broken by short steep slopes along streams. The association extends northeastward through the county in a narrow belt that is just west of Gettysburg. The soils are generally shallow, but they range from very shallow to moderately deep on gentle slopes. Drainage is


GETTYSBURG
Mummasburg Road
Cashtown
Hagerstown Road
Emmitsburg Road
Baltimore Pike
York Pike
Hanover Road
Carlisle
Newville
Heidlesburg Road
Huntersville Road
SEMINARY RIDGE
McPHERSONS RIDGE
McPherson's Woods
Evergreen Cemetery
Pitzer's Woods
Peach Orchard
Devil's Den
Little Round Top
WARFIELD RIDGE
PLUM RUN
CEMETERY HILL
HUNTERS HILL
SURFACE CONFIGURATION (SLOPE)
A – 0 - 5%
B – 5 - 10%
C – 10 - 15%
D – 15 - 20%
E – 20 - 25%
F – 25 - 30%
G – 30 - 35%
H – > 35%


GETTYSBURG
Evergreen Cemetery
Peach Orchard
SURFACE MATERIALS (SOILS)
A – Abbottstown silt loam
B – Brecknock silt loam
C – Croton silt loam, moderately eroded
K – Klinesville shaly silt loam
L – Lehigh silt loam
M – Montalto very stony silt loam
P – Penn silt loam, moderately eroded
Q – Quarry
R – Readington silt loam
W – Watchung silt loam

poor in many places. The Montalto-Mount Lucas-Watchung association is in a belt of low ridges that begin at the northeastern boundary of the county, passes the battleground southeast of Gettysburg, and extends to the Maryland line. Many large boulders of diabase rock (exhibit 1) occur on the more prominent ridges. In the more rugged sections, the diabase ridges have rounded knobs or hills that rise abruptly from the surrounding plain, as does Round Top and Little Round Top. Several other associations exist in the area, but cover only small areas. Specific soil types are shown in figure 3.

VEGETATION

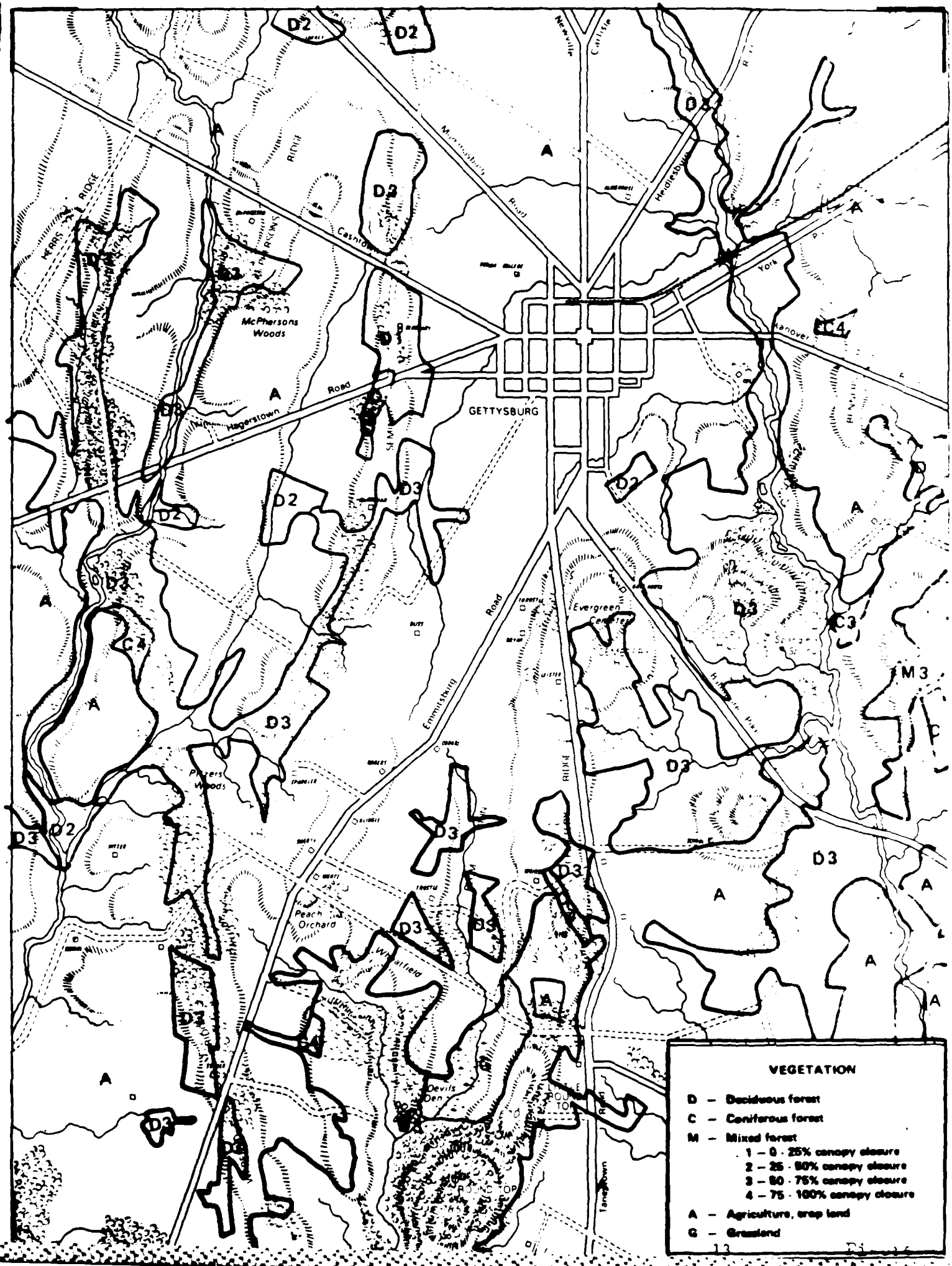
Forests are primarily concentrated along drainage channel, ridge, and upland areas. Typically, most trees belong to the deciduous family varying in height and stem diameter. The principal species are oak, hickory, chestnut, ash, and poplar. Stem density (tree spacing) is moderately dense with large stems ranging from 6 to 12 feet apart, intermixed with smaller stem trees (exhibit 2). Generally, tree heights range between 30 and 80 ft. Small stands of coniferous trees are widely scattered and intermixed with deciduous forests. According to the Forest Service personnel and literature several of the species of oak trees common to the area mature in approximately 100 years, growing approximately 60-80 ft. By modeling these data it can be determined that tree heights were about 15 ft. less during the 1860's, approximately 45 feet. Most of the Gettysburg Plain is and was devoted to the growing of agricultural crops during the Civil War period. Crops principally consisted of wheat, rye, Indian corn, oats, and buckwheat. Today, most of the field patterns in the Gettysburg area existed as they did during the war period. (Figure 4 displays the forest and field patterns.)

Diabase Rock on Little Round Top.

Exhibit 1

Forest located along Seminary Ridge – Deciduous Trees of various ages, heights, and stem diameters.

Exhibit 2

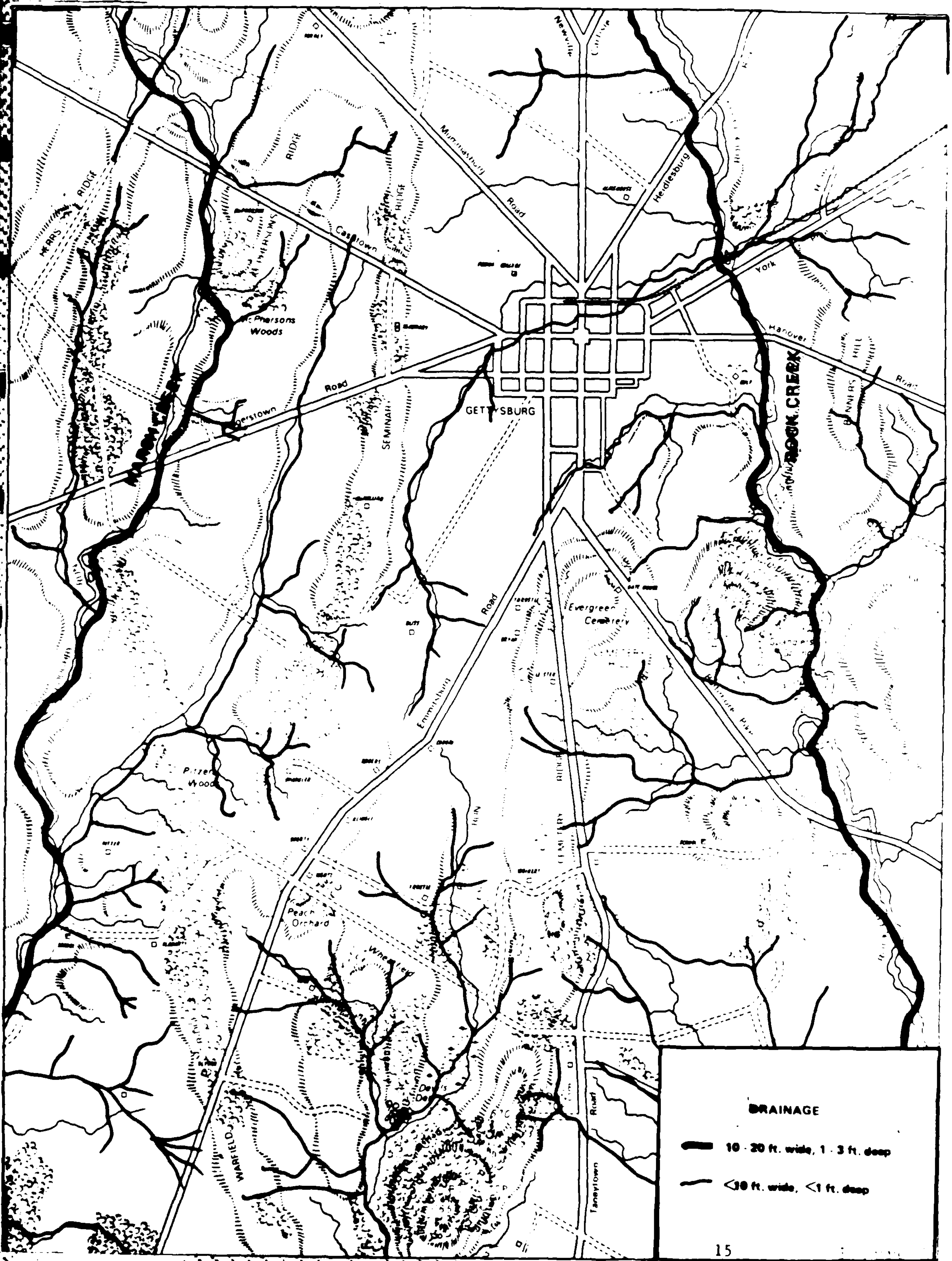

GETTYSBURG
McPhersons Woods
Peters Woods
Peach Orchard
Devils Den
Evergreen Cemetery
Hagerstown Road
Emmitsburg Road
Taneytown Road
York
Hanover
Carlisle
Newville
Harrisburg
Mummasburg Road
Cashtown
Herrs Ridge
Seminary Ridge
Ridge
VEGETATION
D – Deciduous forest
C – Coniferous forest
M – Mixed forest
1 – 0 - 25% canopy closure
2 – 25 - 50% canopy closure
3 – 50 - 75% canopy closure
4 – 75 - 100% canopy closure
A – Agriculture, crop land
G – Grassland

DRAINAGE

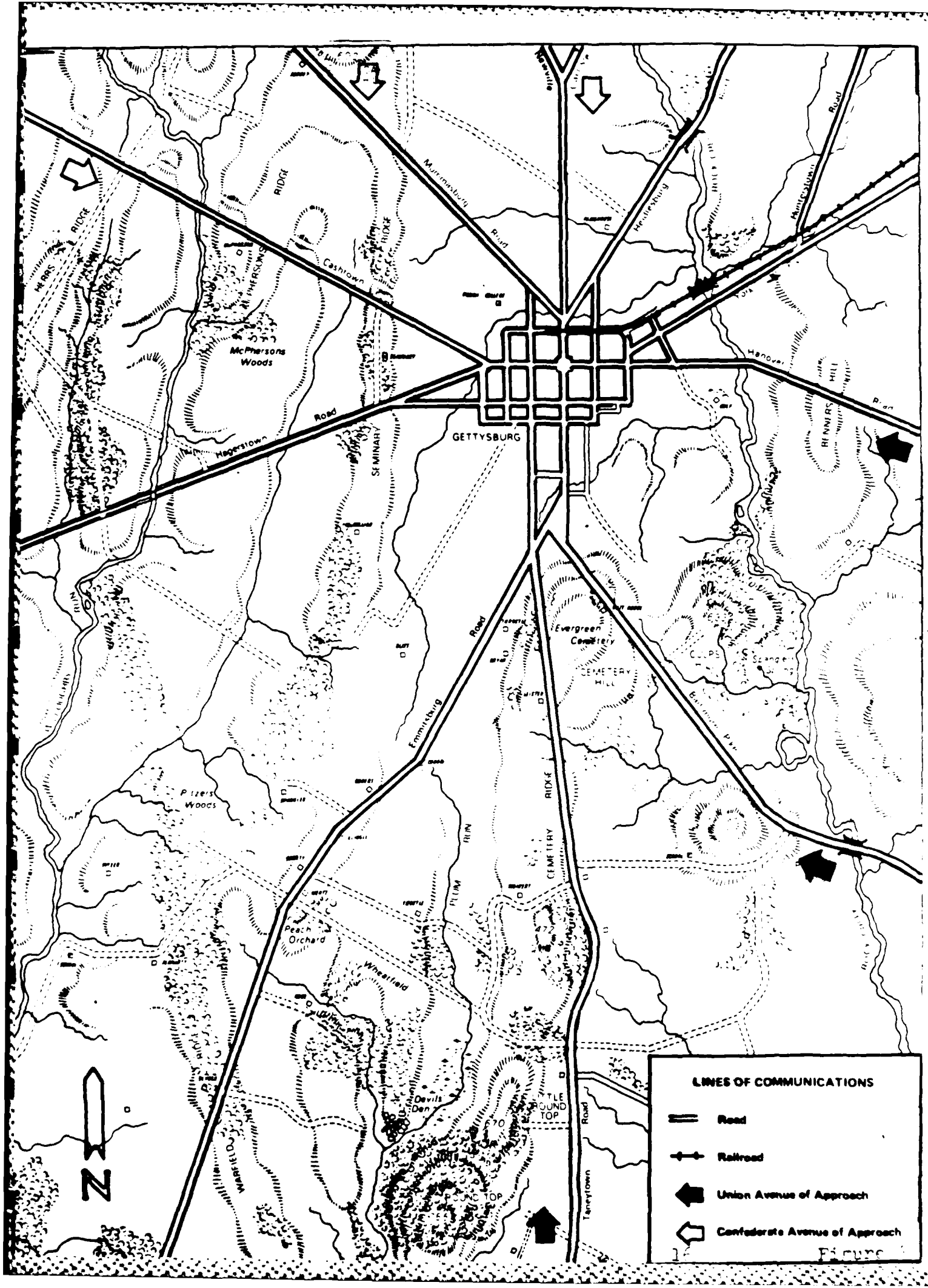
Two primary streams drain the area, Rock Creek flowing southward just east of Gettysburg and Marsh Creek, also flowing southwest of the city. Willoughby Run, a secondary drain emptying into marsh Creek, parallels the western boundary of the battlefield. Each of these streams is relatively shallow, 1 to 3 ft., becoming deeper in some constricted areas. Stream banks are generally steep with moderate bank heights of loose stream bank materials. Numerous smaller drains traverse the area forming a dentritic pattern. The dentritic is the most common drainage pattern and is characterized by a treelike branching system in which the tributaries join the gently curving mainstream at acute angles. The occurrence of this drainage system indicates hemogeneous, uniform soil, and rock materials. (Figure 5 present a representative distribution of stream patterns.)

LINES OF COMMUNICATION

Road approaches to the Gettysburg area extend from all directions. Primarily a farming region throughout history and Gettysburg's location on a slightly rolling plain enabled easy access to the area. So was the case in the 1860's. Primary roads were unimproved, constructed of compacted soils and gravels, and often became miry during wet periods. Figure 6 shows primary routes extending from Chambersburg, Carlisle, Hanover, and areas to the south. A single rail system served Gettysburg which terminated just north of the city. A rail bed had been prepared paralleling the Chambersburg pike, but no tracks had been laid. This rail cut would later turn out to be a significant terrain factor during the first day's battle.



Mummasburg
Road
Heidlesburg
Cashtown
York
Hanover
Road
ROCK CREEK
McPhersons
Woods
Road
GETTYSBURG
SEMINARY
Evergreen
Cemetery
Road
Emmitsburg
Pitzer
Woods
Peach
Orchard
CEMETERY
RIDGE
WARFIELD
Road
Taneytown
DRAINAGE
10 - 20 ft. wide, 1 - 3 ft. deep
<10 ft. wide, <1 ft. deep


GETTYSBURG
McPherson's Woods
Seminary Ridge
Cashtown Road
Hagerstown Road
Mummasburg Road
Harrisburg
Hanover
Evergreen Cemetery
Cemetery Hill
Emmitsburg Road
Peach Orchard
Wheatfield
Devils Den
Little Round Top
Round Top
Taneytown Road
Warfield Ridge
Run
LINES OF COMMUNICATIONS
Road
Railroad
Union Avenue of Approach
Confederate Avenue of Approach

CHAPTER IV

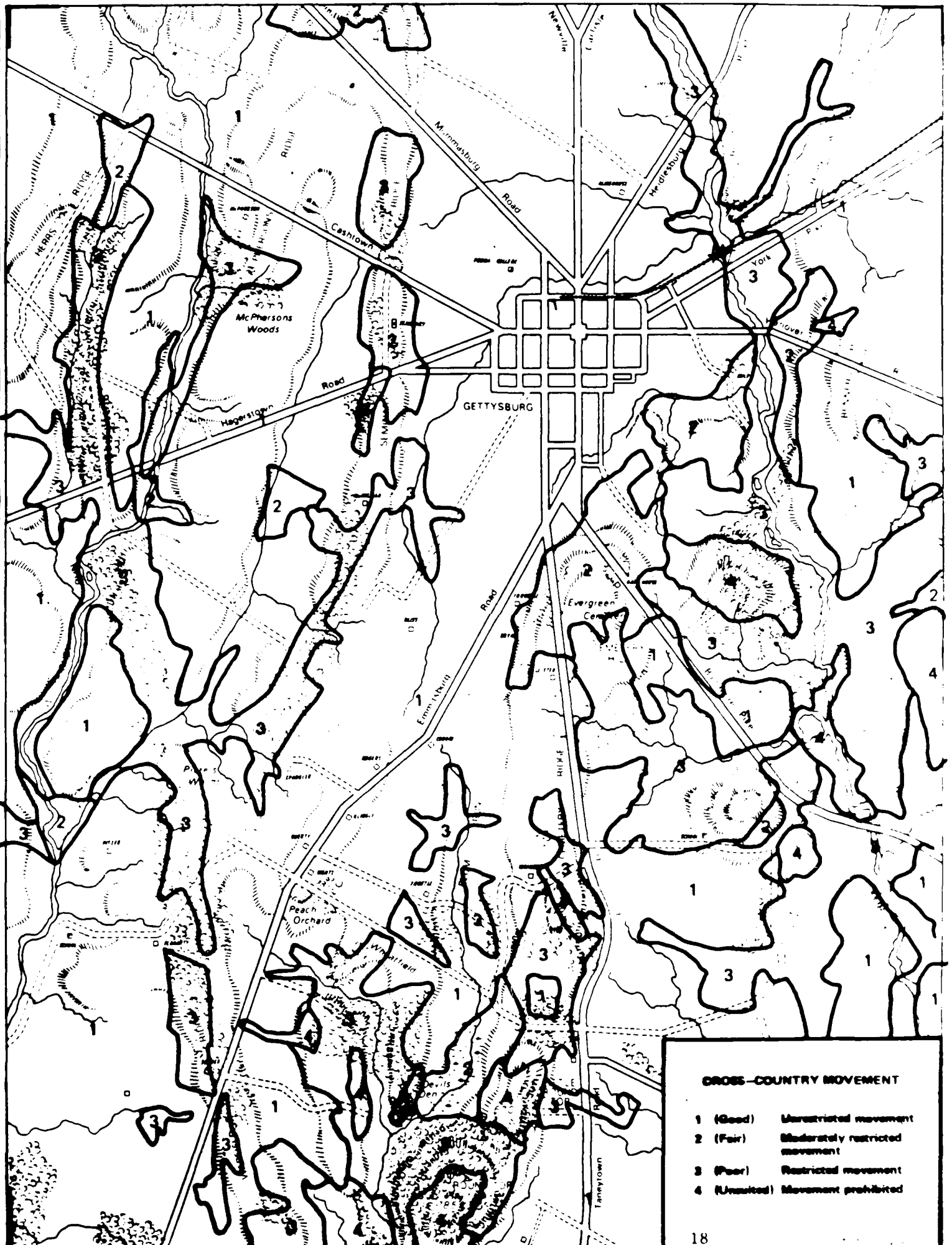
PRODUCT DEVELOPMENT

Once the factor overlays (data bases) have been compiled, the data are processed through a product synthesization procedure. In general, this process involves using the factor overlays which portray added terrain conditions, stacking one on the other and using a clear piece of overlay material to compile a complex overlay. The complex overlay is merely a coded representation of all the conditions that exist on the factor overlays portrayed on one overlay. This overlay becomes the base from which a package of products can be generated. Mathematical models are applied to the quantified data on the complex overlay enabling predictions to be calculated concerning cross country movement, terrain masking, avenues of approach, etc.

SYNTHESIZED PRODUCTS

CROSS COUNTRY MOVEMENT

In the normal sense, cross country movement potential would be evaluated for foot, wheeled, or track vehicles. In this case, discussion will concentrate on movement potential for foot troops and wheeled horse-drawn artillery. Foot movement was not precluded due to severe terrain conditions, however, movement would be slowed by dense vegetation and steep slopes. Wet, miry soils would further hamper mobility during rainy periods. Normal rate (2-4 mph) movement of wheeled artillery is primarily restricted to the existing roads. Off-road movement is moderately restricted by forests, deeply incised drainage, and steep slopes. Figure 7 evaluates the effect of terrain on cross country movement potential primarily for wheeled, heavy artillery.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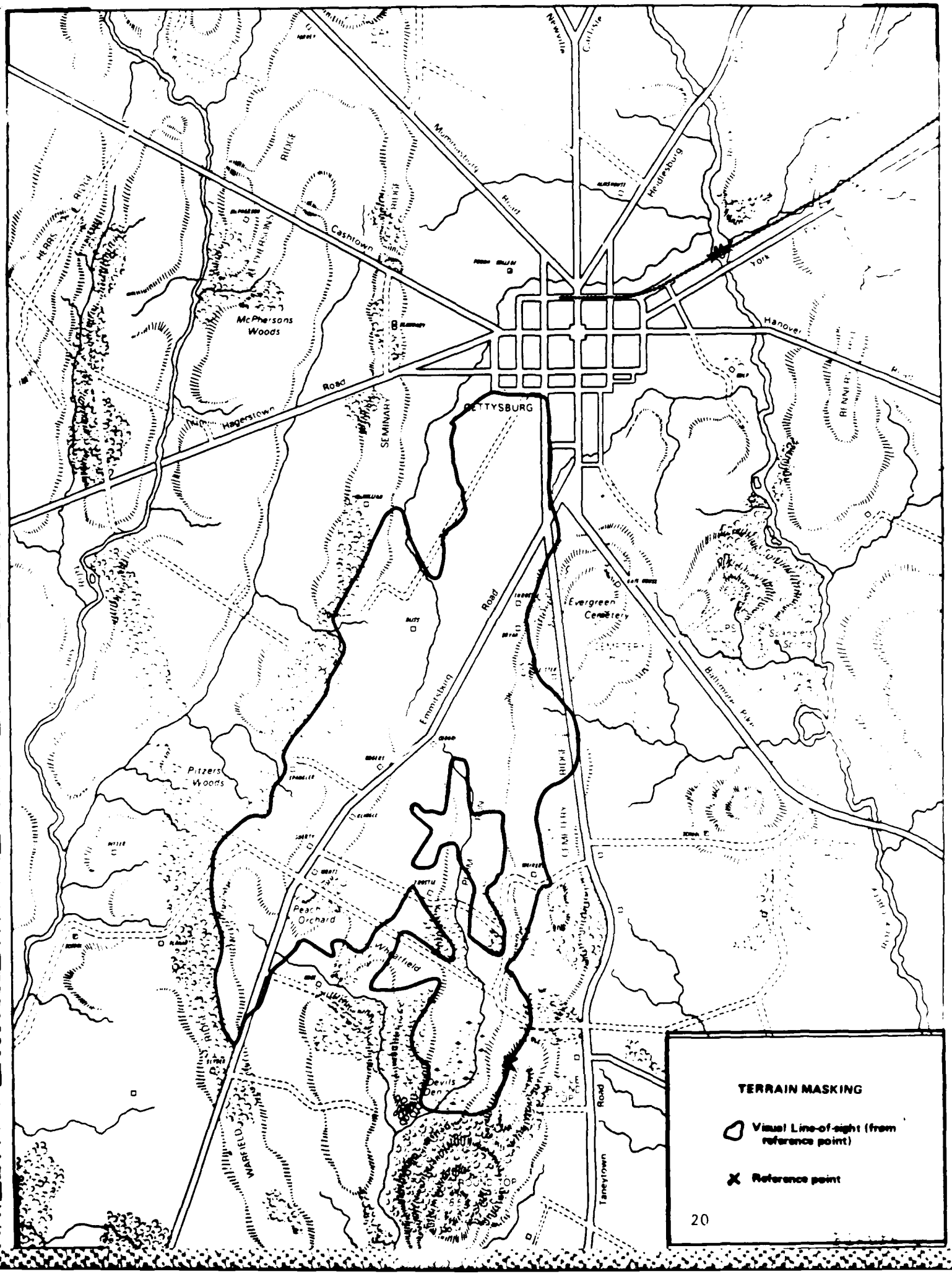
McPhersons Woods
Hagerstown Road
GETTYSBURG
Emmitsburg Road
Taneytown
Peach Orchard
Devils Den
Evergreen Cem
York
Herdlesburg
CROSS-COUNTRY MOVEMENT
1 (Good) Unrestricted movement
2 (Fair) Moderately restricted movement
3 (Poor) Restricted movement
4 (Unsuited) Movement prohibited

TERRAIN MASKING

Figures 8-10 depict visual line-of-sight from several selected points. Each line-of-sight is based upon the elevation of the reference point, forest patterns, tree heights, and elevation of the surrounding terrain. These overlays, as a result, show areas masked by terrain. Ground photos (exhibits 3 and 4) were taken from reference points 1 and 2.

AVENUES OF APPROACH

Approaches to the area were briefly discussed under lines of communication. On a broader perspective mountains border the study area channeling approaches from the west through narrow passes. Several isolated high hills reach above the surroundings to the south. Lower rolling hills dominate the eastern and northern parameters of the study area. Consequently, approaches to the Gettysburg area are only moderately restricted from the west.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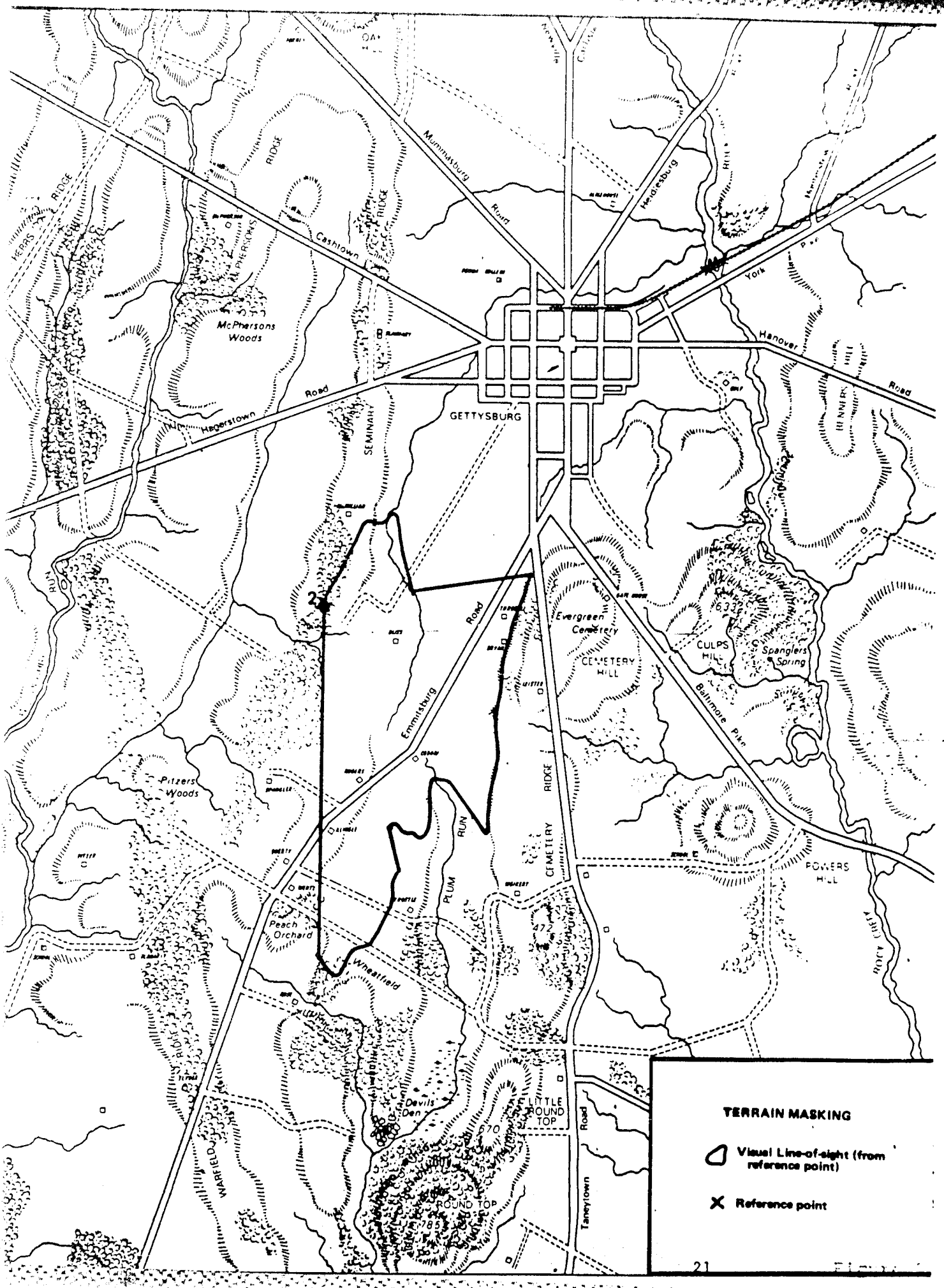
Baltimore Pike
Pitzers Woods
Peach Orchard
Devils Den
WARFIELD RIDGE
Taneytown Road
TERRAIN MASKING
Visual Line-of-sight (from reference point)
Reference point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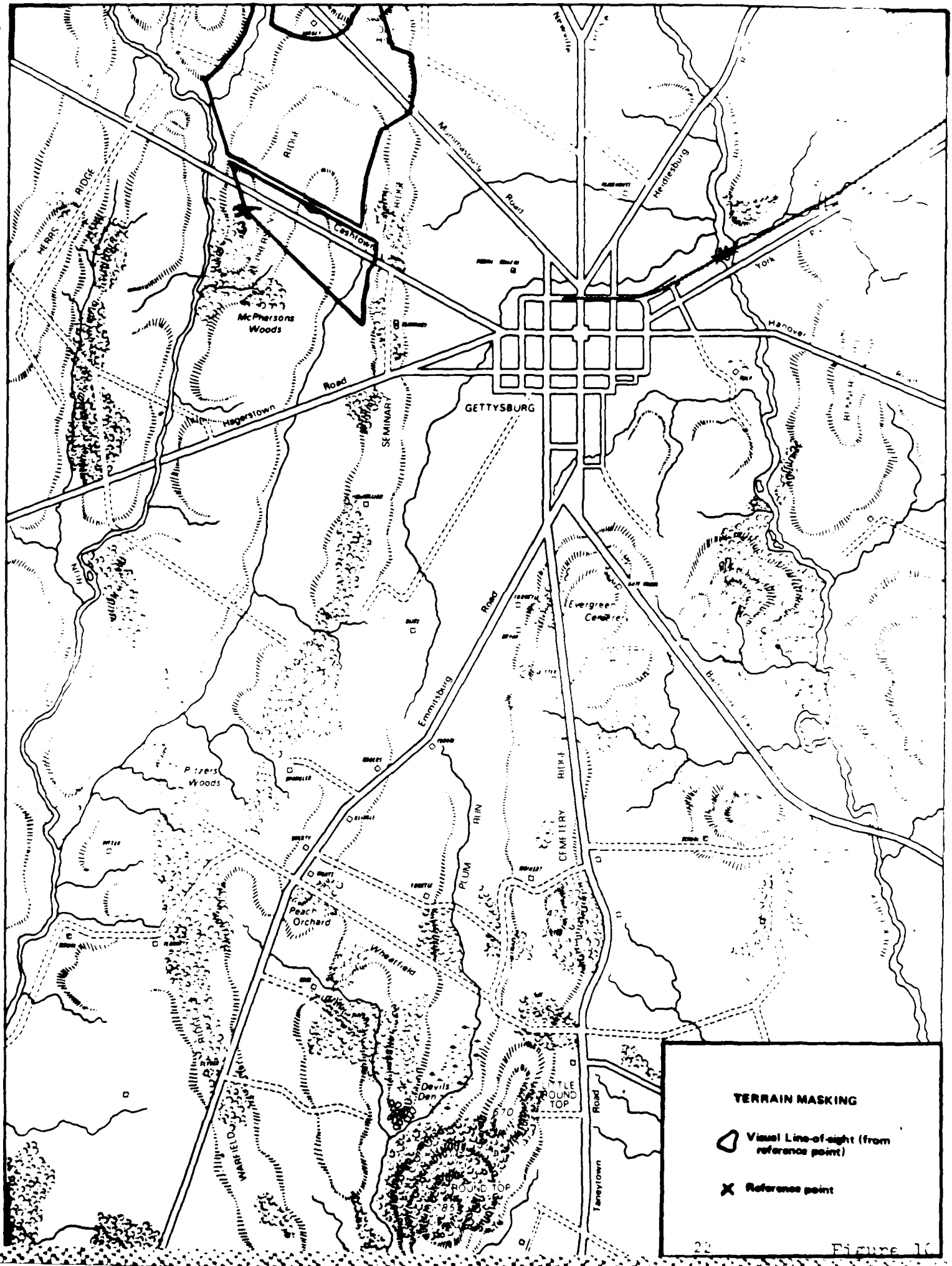
Culps Hill
Spanglers Spring
Baltimore Pike
Emmitsburg Road
Pitzers Woods
Peach Orchard
Wheatfield
Plum Run
Cemetery Ridge
Powers Hill
Devils Den
Little Round Top
Round Top
Taneytown Road
Warfield Ridge
2
TERRAIN MASKING
Visual Line-of-sight (from reference point)
Reference point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Hanover
Hagerstown Road
GETTYSBURG
SEMINARY
Emmitsburg Road
Taneytown Road
McPherson's Woods
Peach Orchard
Wheatfield
Devils Den
ROUND TOP
LITTLE ROUND TOP
CEMETERY RIDGE
PLUM RUN
WARFIELD RIDGE
TERRAIN MASKING
Visual Line-of-sight (from reference point)
Reference point

Figure 16

View from Little Round Top.

Exhibit 3

View from Seminary Ridge east toward Cemetary Ridge.

Exhibit 4

CHAPTER V

CONCLUSION

The preparation of the data bases and the synthesization of the selected products does not appear to have revealed any significant revelations that would have changed the outcome of the battle. The occurrence and timing of events on both the Union and Confederate sides appear to have played more important roles in the outcome of the battle than terrain factors. It is not as if the battleground had been preselected by both armies, each efficiently planning strategies and operations by carefully surveying the terrain. The location of the battle that would effectively lead to the defeat of the Confederacy was a classic example of circumstances being overtaken by events.

The purpose of this paper was not to prove or disprove whether a specific terrain factor or series of factors influenced the outcome of the battle. The purpose is to present the terrain conditions as they existed in the 1860's. The study is to serve as a tool to assist historians in analyzing the battle. I would conclude that the terrain conditions presented would have influenced and did influence military operations during the battle as they did in other battles and wars. The commander who utilizes the terrain effectively will accomplish the mission successfully in most cases. This certainly was the case for the Union forces. They assumed the "high ground" in a defensive posture making it very difficult for the invasion forces to assault their positions.

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